Plant Physiol. (1970) 45, 647–648

Short Communication

Circadian Leaf Movements in Biloxi Soybeans[1]

Received for publication October 24, 1969

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Leaf movement in Biloxi soybean has been investigated in some detail by Bünning (1) and Holdsworth (2). The results and the interpretations presented by these investigators differ with regard to the nature of the leaf movement response. Bünning considers the leaf movement to be a circadian manifestation of the physiological clock, while Holdsworth considers it to be essentially a photonastic response. The purpose of this investigation is to determine more precisely the nature of the leaf movement response.

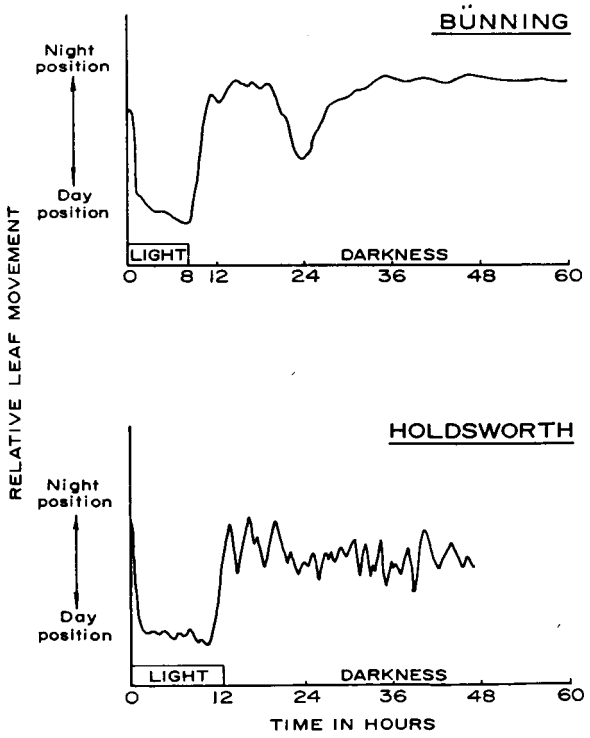

FIG. 1. Comparison of the results reported by Bünning and by Holdsworth for Biloxi soybean leaf movement in continuous darkness.

In all of the experiments reported here the movement of the leaves was measured with a kymograph designed in this laboratory. The experiments were carried out in growth chambers maintained at 28 ± 1 C during the light period and 22 ± 1 C during the dark periods. The light source consisted of four General Electric power-groove fluorescent lamps which provided an illuminance of approximately 10,000 lux at the leaf surface. Seeds of Biloxi soybean (*Glycine max* L. Merr.) used were obtained from Dr. H. A. Borthwick (United States Department of Agriculture, Beltsville, Md.). The plants were grown under long day conditions in a greenhouse until ready for use. In all experiments the plants were pretreated in the growth chamber with two 24-hr light-dark cycles consisting of 16 hr of light and 8 hr of darkness (16L:8D). Only fully expanded leaves were used for measurement. Four plants were used in each experiment. The experiments were repeated at least three times.

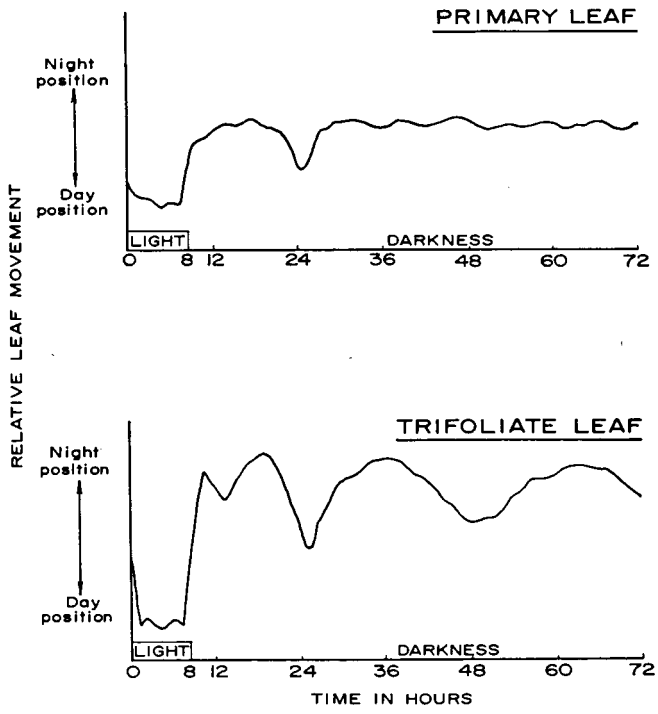

FIG. 2. Comparison of movement of primary and trifoliate leaves of Biloxi soybean exposed to 8L:64D treatments. The photonastic response is seen at the 8-hr point. Average movement of 27 leaves.

In Figure 1 the results obtained by Bünning (1) and Holdsworth (2) of leaf movement in continuous darkness are shown. The amplitude of the leaf movements is an approximation since Holdsworth's data were presented in degrees of leaf angle while Bünning presented kymograph curves. Holdsworth's results show essentially no rhythmic circadian variation in the leaf angle

[1] This work was supported in part by National Science Foundation Grant GB 7576 and by National Aeronautics and Space Administration Grant NGR-05-007-174.

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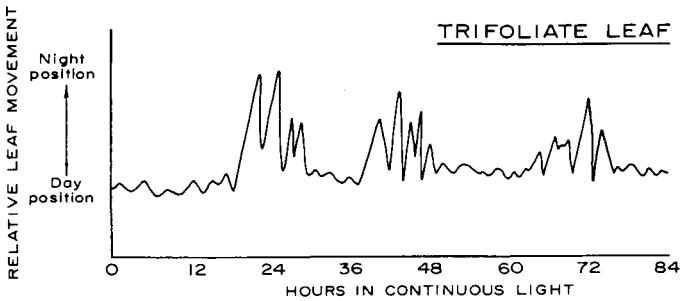

FIG. 3. A typical kymograph record of a trifoliate soybean leaf exposed to 84 hr of continuous light.

while Bünning's results indicate that the leaf completes one rhythmic oscillation in the dark. After this oscillation is completed, the leaf remains in its night position until it is again exposed to light. One interesting difference in the two investigations is that Bünning based his results on the movement of a primary leaf while Holdsworth based his on the movement of the terminal leaflet of a trifoliate leaf.

In order to determine whether the experimental differences reported by Bünning and by Holdsworth could be due to the use of these different leaves, the soybean plants were given a single 8L:64D treatment. A striking difference is seen between the movement of the primary leaves and that of the trifoliate leaves (Fig. 2). The primary leaves, as previously reported by Bünning, displayed only one oscillation during the 64-hr dark period, while the trifoliate leaves, contrary to Holdsworth's results, displayed three complete circadian oscillations. These results provide definite evidence that leaf movement in Biloxi soybean may be considered as a circadian rhythm. It is interesting to note that in addition to the rhythmic movement, the leaves exhibit a distinct photonastic movement which is extremely rapid, usually requiring no more than 30 min to move from the day to night position or vice versa. The circadian component of the leaf movement, on the other hand, may require up to 12 hr for expression.

Further evidence of the circadian nature of the leaf movement was obtained when the movement of the trifoliate leaves was measured in continuous light and constant temperature (Fig. 3). The response of the leaves in continuous light is quite different from that found in continuous darkness. However, the movements still exhibit a pronounced circadian rhythm which persisted for as long as 2 weeks. The temperature independence of the rhythm has not as yet been thoroughly investigated. However, preliminary studies indicate that a temperature differential of 7 C has no effect on the period length in continuous darkness.

The results presented here provide evidence that the leaf movement of Biloxi soybean does represent a circadian rhythm and supports Bünning's conclusion (1) that the leaf movement is a manifestation of the basic physiological clock.

Acknowledgments—We are indebted to Mr. Jack Rader for his technical assistance. We thank National Aeronautics and Space Administration and the Air Force Office of Scientific Research for their generous support without which this work would not have been possible.

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